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mixed with chlorid of silver, the presence of alkaline chlorid seeming to have the property of preventing the volatilisation of chlorid of silver.

In all the first trials, the button of gold was found to weigh considerably less than before the process, and the accidental breaking of one of the tubes shewed that in the part directly over the tray several globules of gold adhered, having probably been thrown up thither by the ebullition of the alloy when the chlorine was first passed over it. Having thus discovered the cause of the failure, the process was twice more repeated, taking care to give only a low red heat in the beginning, and to pass the chlorine slowly. With these precautions, the button of gold, remaining at the end of the process, was found to be exactly equal to its original weight as shewn by a balance that indicated well to the $\frac{1}{200}$th part of a grain.

7 Bloomsbury Square. A. AIKIN.

No. II.

GALVANIC BATTERY.

The GOLD ISIS MEDAL *was presented to Mr.* ALFRED SMEE, *Surgeon, Bank of England, for the following Communication on a Galvanic Battery of a new Construction; a Model of which has been placed in the Society's Repository.*

THE most valuable instrument which chemists employ for their analytical experiments is, no doubt, the galvanic battery; but so much trouble attends its use, that, except in the laboratory of the professed chemist, it is not employed to any considerable extent. Experiencing this inconvenience in the experiments which I conducted on the red ferrocyanate of potash, it became a matter of the greatest importance to ascertain how far a battery could be constructed, that at once should possess a capability of being used at a moment's notice, and have besides considerable power united with cheapness of action, and, at the same time, without the necessity of much laborious cleaning after its employment.

After experimenting with the batteries before known to the public, I became convinced that it was of the highest importance to supersede the necessity of diaphragms, attended as they are with continual trouble and expense; and as the power of the battery seems to depend upon the facility offered to the evolution of the hydrogen and preventing its adhesion to the negative metal, whereby it is coated as with a varnish, and the action almost entirely destroyed, all my experiments were directed to this object. I first perceived that the gas was not evolved equally from every part of the surface of a smooth piece of platinum, but chiefly from the corners, edges, and points. Following this hint, I roughened the metal with sand-paper and found the evolution of the gas to be increased; and when the surface of other metals, as silver or iron, was roughened by some acid, I found the gas also to be much increased. Moreover, zinc shavings, which present the singular anomaly of having one surface extremely bright and the other of a delicate frosted appearance, shew this property well, gas being freely given off from the rough, but adhering firmly to the bright surface. The same differences are also observed when rough and polished steel are employed. These experiments induced the idea that spongy platinum, which may be considered as a mass of metallic points, would be very efficient in forming a galvanic circuit; and on trying the experiment, the quantity of hydrogen evolved from a minute portion of this substance, when touched with a piece of zinc, was truly astonishing. The mass in this state was so fragile, that the hydrogen disintegrated it almost instantaneously, shewing that in this form it could not be used for a voltaic battery.

My next experiments were to coat other metals with this finely divided platinum; and I found that platinum, palladium, or silver, answered admirably for the reception of it, and similar help was afforded to the evolution of the hydrogen as the contrast between the gas given off from the smooth metal and rough metal forms a most striking experiment. Other metals received the platinum with advantage; as plated copper or iron, and even charcoal, was benefited to a similar extent.*

The metals thus roughened by platinum have, in addition to their power, some properties which are very interesting; thus, when a piece of the prepared metal is placed in dilute sulphuric acid and touched with a small rod of zinc, gas is not given off from its whole extent, but only from the space of a small circle; and when contact is completed with a smooth piece of platinum, the gas will not be given off from the latter, but will travel principally to the rough portion, there to be evolved. This curious experiment affords a marked difference from those cases where the hydrogen is absorbed, as when a piece of silver is touched with a rod of zinc in dilute sulphate of copper, for in this case an immense circle of copper will be thrown down.

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* Charcoal and plumbago might be considered to afford points enough for the escape of the hydrogen, but to these there is great adhesion of the gas.

A difficulty now arose in this stage of the proceeding, for the finely divided platinum was so easily rubbed off that it could not be practically used with advantage. However, when the silver or other metal was first roughened by the removal of the surface by an acid, then the adhesion was so great that a piece of platinum thus prepared was sent accidentally to the instrument-maker, where the workman mistook the finely divided platinum for dirt, and could only remove it with sand-paper.

It now became desirable to ascertain the power of the metal thus prepared relatively with the other batteries, and also with metals uncovered with the finely divided platinum; and to make this comparison, I perceived that considerable difficulty occurred, for as this preparation of the metals increases the quantity, but does not interfere with the intensity, a fair comparison can not be made where there is any impediment or difficulty to be overcome, unless that difficulty be superseded by increasing the number of cells of the battery; and therefore, had I at first taken the decomposition of water as the test for my numerous experiments, they would have been attended with an immense expense; had I taken the heating of wire as my test, that would also have been uncertain, according as the heating of large or small wires was estimated, but I considered that a close relative estimate of power could be ascertained by the magnetical effect; for, by using large wires round the temporary magnet, but little impediment was offered to the current, and thus the quantity, independent of the intensity, could be accurately ascertained; and in repeating my experiments, at different times, on the same magnet and with the same surface of like metals, I found that they coincided with remarkable accuracy, and only one cell was required for the experiment. Though the weight, which was supported even by a small magnet with *large wires*, was inconveniently great, I determined to ascertain the distance at which a small but lesser weight was attracted.

The following are the results of like surface of metal with the same metal:

	Layers of paper.
Smooth silver, supported keeper through..	2
Smooth copper	1
Silver heated, quenched in acid	9
— surface removed by nitric acid	9
Iron rough	8
Daniell's battery	6
Platinised silver......................	20
—— iron, two or three varieties	20
—— platinum	18
Grove's battery	26
— platinised platinum	30
Plain platinum heated, quenched in acid..	12

By these experiments we see the great advantage of the rough metals and those covered with platinum over the smooth metals and Daniell's arrangement.

The only metal which may take the place of finely divided platinum is palladium, but probably rhodium, iridium, and osmium, would have the same property as they are precipitated in a fine black powder by zinc. The cause of this black colour is not at all evident; and the form of the black deposit has eluded not only my own but the observation of others, although aided by the microscope. Probably, however, the colour is owing to the particles being too small to reflect the light, as is said to be the case with a specimen of quartz in the cabinet of the Duchess of Gordon, but this is merely hypothetical.

We have now seen that platinum, palladium, silver, plated copper, or iron, are suitable for the finely divided metal, and these are to be first roughened, the two former with sand-paper and the three latter with a little nitric acid, which is to be again cleaned off by washing. The metals are then to be placed in any convenient vessel with a little dilute sulphuric acid, to which a small quantity of nitro-muriate of platinum has been added; a porous tube or paper bag, containing a piece of zinc, with more dilute sulphuric acid, is also to be placed in the vessel, when, as soon as the circuit is completed, the platinum is precipitated on the metal placed for its reception. The cost of this process will be best understood by mentioning that the assayers sell one ounce of the prepared silver for one shilling above the price which is charged for the silver alone.

The zinc which is used for the battery should be the best thick rolled zinc, as this is far preferable to the cast zinc, and it is to be amalgamated with mercury aided by dilute sulphuric acid; for, the application of this process to the zinc of my battery will be found, unlike other batteries, not to require repeating.

The form which is most suitable for the battery appears to me a matter of fancy rather than of importance,—one circumstance alone being requisite; that is, if we are desirous of obtaining the greatest power with the utmost economy of silver, it is requisite that every portion of silver should be opposed to a piece of zinc, but the size of the latter, within moderate limits, is but of little consequence.* Thus, if we use the many-celled porcelain trough, it is better to surround the silver by zinc in the same way as the copper surrounds the zinc in the old Woollaston battery. If the circular form be adopted, a piece of zinc should be placed in the interior as well as the exterior of the cylinder, as by that means both surfaces of the silver are brought into action; if the Cruikshanks be adopted, one surface is necessarily lost, but in this case plated copper answers sufficiently well, as the edges are sunk into the cement which, if exposed as in the other forms, are apt to have a portion of the copper dissolved, which is again deposited on the silver, and is liable to become oxydised and be detrimental to the power of the battery. The closer the zinc can conveniently be brought to the other metal, the more favourable will it be.

Whichsoever form is adopted, the power will depend on the series and size of the plates. For decomposition of water and most other purposes, it is better to have twelve pairs of plates and then to increase their size. The battery having twelve five-inch plates, which was exhibited to the Committee of the Society of Arts, gave off fifteen cubic inches of mixed gas in the first minute, and shewed great calorific power by immediately burning stout steel music wire.

The duration of the action of the battery will depend, like a fire, upon the quantity of fuel supplied to it in the first instance, for, as there is no local action, it follows that the solution of the zinc will be exactly proportionate to the power produced; and for this reason, when the battery is required to continue in operation for a long period, as in the method which I detailed elsewhere for the production of electrotypes, a larger receptacle for acid should be employed, or a contrivance can easily be adopted to carry off gradually, by means of syphon tubes, the saturated solution of sulphate of zinc, whilst at the same time dilute acid is supplied from another tube.

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* It is of great disadvantage to employ the zinc too small, as a simple rod to a large cylinder of silver. A certain quantity of zinc seems absolutely necessary to elicit the full power of this arrangement.

A galvanic battery thus constructed owes its increase of power to the mechanical evolution of the gas, and as the experiments of Faraday have shewn that the source of power in any voltaic pile is chemical action, I have ventured to call my form of apparatus the "Chemico-Mechanical Battery."

To those versed in electrical science it may be needless to mention, that, this form of battery simply increasing the quantity of electricity, it is most important that large communications and large wires should be used in its construction, or else the whole of the additional power might be lost.*

The advantages of the Chemico-Mechanical Battery are, the cheapness in its employment, and its requiring not only less manipulation than any other battery, but also less cleaning. It can be put into action at a moment's notice, and, after having been used, can be as readily laid by. When in the fluid it will be quiet till communications are made, and will then possess considerable power. It neither gives off poisonous fumes nor requires the aid of strong acids, and but one fluid is employed; and, lastly, the amalgamation of the zinc does not require to be renewed. Such are the principal advantages of this battery, and they appear to be sufficient to entitle it to the very extensive application which it has met with; but, in conclusion, I wish to be clearly understood that it does not possess the absolute constancy of Daniell's, or the intensity of Grove's battery.

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* This I have actually known to be the case: the power of the battery being almost destroyed by the use of small wires and small connexions.

ALFRED SMEE.

Bank of England,
June 1, 1840.